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Pacific Northwest Soil Erosion Experiment Station,
United States Department of Agriculture, and
Washington Agricultural Experiment Station,
State College of Washington, cooperating.

Erosive Effects of Heavy Summer
Rains in Southeastern
Washington

By

W. A. Rockie and P. C. McGrew

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Erosive Effects of Heavy Summer Rains in Southeastern Washington

By W. A. Rockie¹ and P. C. McGrew²

Introduction

Violent summer rains are less frequent in the Pacific Northwest than in most parts of the United States, but this region is not immune to their destructive forces. The conditions and results of an individual storm of the type that is infrequent but none the less damaging, are described in this paper.

The region involved is that unique area which has been described as the "Palouse" country. Topographically, this is an area of choppy relief, with many steep short slopes and with very complete deeply-intrenched drainage of an imperfectly dendritic pattern. It includes very little level land, and consists dominantly of slopes having gradients of from 20 to 40 per cent. Many slopes have grades of 50 per cent with extreme gradients of more than 60 per cent.

The region is given over almost entirely to the growing of wheat, most of the land being fallowed every second or third year. In spite of the steep slopes there is little untilled land. Heavy power machinery is used to a large extent, and single farms range up to several thousand acres in extent.

Farming, as it is carried on in this region, could not be conducted upon such steep slopes in a region of violent summer rainfall. It is only because most of the precipitation in this region falls either as snow or as gentle rain that successful and profitable farming has been carried on over a period of more than fifty years.

Location and Character of the Storm

On July 30, 1931 a heavy rain occurred over an area of about 50 square miles south-southwest of Colfax, Washington. The exact location of the area is shown on Map No. 1. Light rains were general, with but a trace of rain at Pullman, Lewiston had .02, La Crosse .14,

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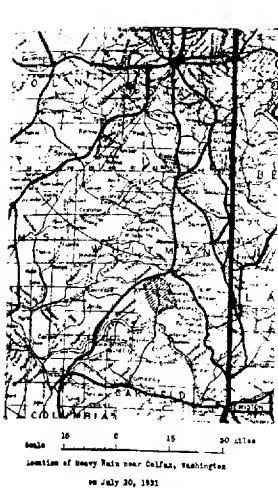
³Bryan, Kirk—The "Palouse Soil" Problem. Bulletin 790-B, U. S. Geological Survey, 1927.

Colfax .21, and Moscow .06 of an inch. The area principally affected by this storm is situated about 10 miles west of the Pacific Northwest Soil Erosion Experiment Station, and is a part of the same physiographic region in which the erosion station is located, having the same type of topography. It seems a reasonable assumption that such a rain may occur at any time and anywhere within the broad region characterizing southeastern Washington and contiguous territory in Oregon and Idaho. In fact, general inquiry throughout the Palouse region has revealed that practically every locality within the region has suffered from one or more very severe summer rains since farming began in this part of the country. It appears probable, from the evidence studied, that during the last 50 years (the period of cultivation) the Palouse region has suffered generally from just such erosion as was caused by the 1931 storm over the area specified above. It appears important, therefore, to look ahead and make provision for as great protection of the land as may be practicable.

During several days succeeding the rain storm of July 30, 1931 careful studies and measurements were made within the area affected. In a number of fields repeated measurements were taken of the widths and depths of gullies produced by this storm. These measurements were used as the foundation for the general estimates appearing in this paper. Detailed measurements were made on a tenth-acre plot of the depth of the remaining loose soil material (measured down to plow-sole). These data are shown on a map elsewhere in this report. Numerous inquiries of residents within the area yielded other fundamental facts which gave a background for some of the statements made here.

According to all information and evidence obtained, the heavy rain lasted only a very short period. Verbal accounts of the duration of precipitation differ considerably within the region affected, indicating that the storm was not of precisely uniform character over the entire area. The only definite record obtainable regarding the amount of rain that fell was from Mr. W. P. Gilbert, a farmer who lives just inside the limits of the area showing evidence of heavy rainfall. At his house, which was very close to the northeastern edge of the storm area, 1.6 inches were recorded in 20 minutes, while on a more distant part of his farm, one mile to the west of the house, his measuring gage actually caught three inches of water. This gage consisted of a straight-sided five gallon oil can with open top. While it is quite possible that more rain fell at some individual spots within the area than these records indicate it has not been possible to obtain any other figures.

Striking proof of the violent character of the storm was shown by the amount of runoff on a smooth southerly slope having a length



MAP 1



MAP 2



Sketch Map Showing Amount of Soil Removed from a Typical Tenth-acre Plot on the Holbrook Farm, Sec. 21, T. 15 N., R. 43 E., Whitman County, Washington.

Depth of Soil Lost	Per Cent of Area
6 to 10 inches	44.5%
3 to 6 inches	35.2%
1 to 3 inches	20.4%
Total	100.0%

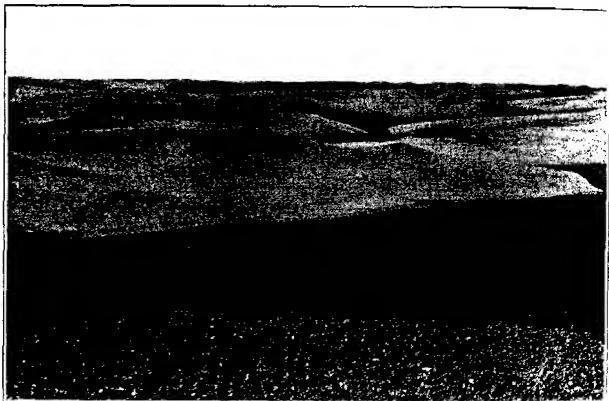
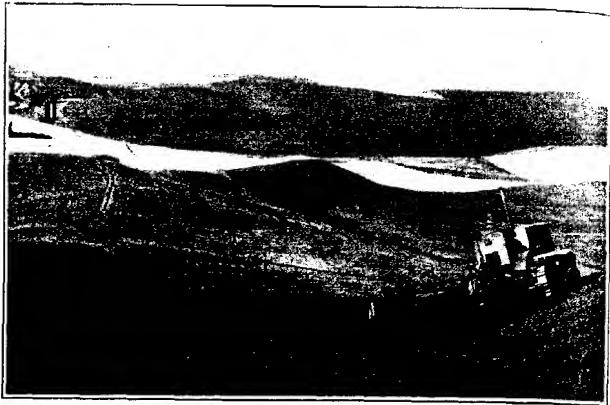


PLATE I

Typical Palouse topography looking North (Above) and West (Below) from the Pacific Northwest Soil Erosion Experiment Station near Pullman. These views show especially well the alternating fields of wheat and summer fallow.

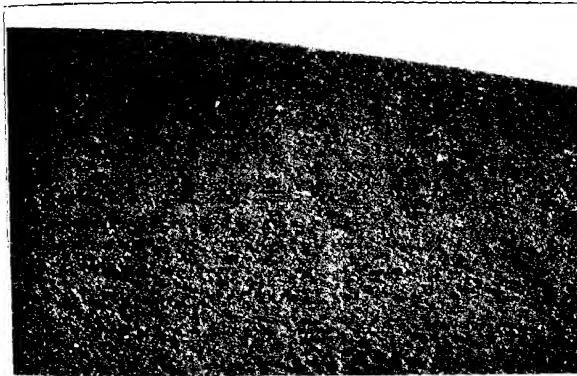
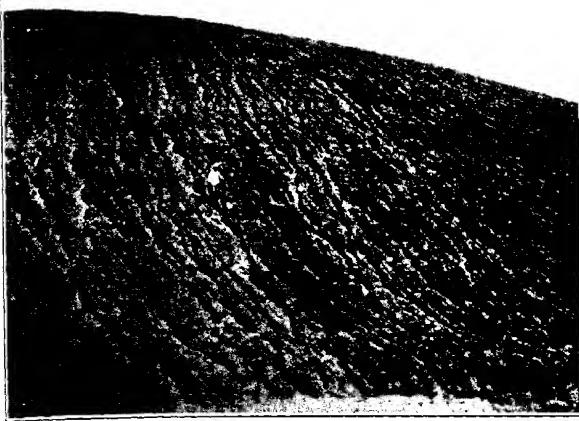


PLATE II

A. (Above) A typical summer fallow field after heavy rain of July, 1931.
B. (Below) The same land several weeks later, after it had been disked.

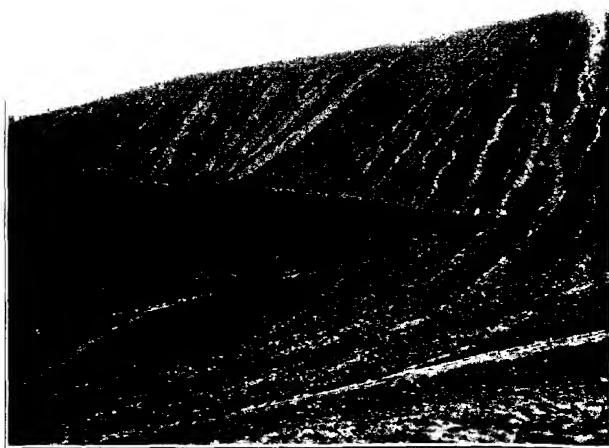


PLATE III

A, (Above) A steep slope of summer fallow land showing typical erosion following this storm, but also showing a wedge of uncultivated land covered by grasses and shrubs. This vegetated area did not erode.

B, (Below) Showing an area in summer fallow land from which all of the loose soil was washed away, leaving the plow-sole exposed. The marks of the plow show plainly

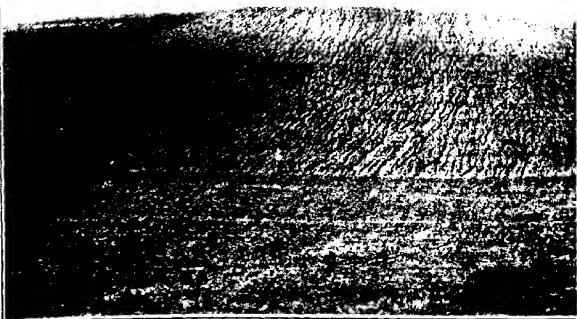


PLATE IV

Summer fallow on upper slope, winter wheat planted in early summer for summer pasture on lower slope. Even this very limited amount and open type of vegetation absolutely stopped all visible erosion damage to the land.

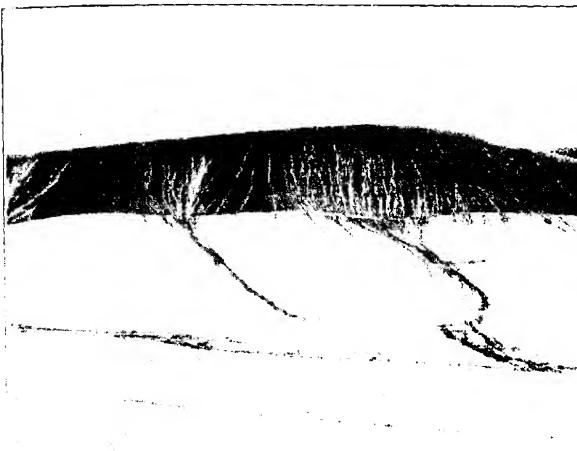


PLATE V

Upper slope is summer fallow, lower slope is wheat stubble. The stubble made a very effective control of erosion. It also strained the silt out of the muddy water from the summer fallow fields above, except on the larger gullies. Here the momentum was too great for the stubble to stop it.

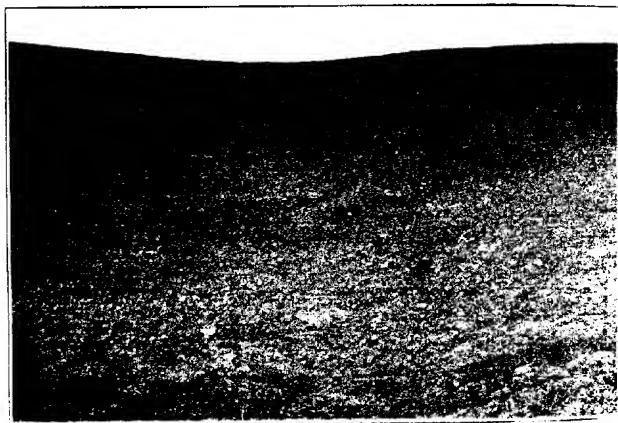


PLATE VI

A, (Above) A summer fallow field which suffered seriously from erosion. All farm work is generally done along the contour in this region. Disking of this land has been started in the central part of the picture.

B, (Below) The same spot several weeks later, after disking had almost obliterated all evidence of this damage.

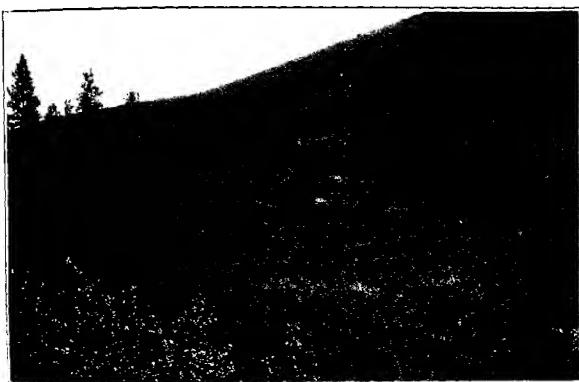


PLATE VII

A. (Above) Showing standing wheat after this storm. While the wheat crop itself was rather heavily damaged, the land showed no indications of washing on slopes which had they been in summer fallow, would have been serrated by small gullies.

B. (Below) Alfalfa field after this storm showing no evidence of erosion.

from top to bottom of about 450 feet and a width along the contour of about one-half mile, which slope was typical of numerous others throughout the region under discussion. Along the foot of this slope a barbed-wire fence followed the contour line. The lowest wire of this fence averaged 8 inches above the ground before the storm; the second wire stood 18 inches above the ground and the third 27 inches. On July 30 water rushing down from the smooth slope above brought with it soil and vegetable litter, which was piled up against the two lower wires, and formed a solid mat of litter and soil that reached from the ground to the wire 18 inches above the ground. The evidence showed that over the long smooth slope a blanketlike flood of rain-water had accumulated. This impinged against the fence to a depth exceeding 18 inches, and at some points was almost 27 inches deep.

Evidences of the violent dynamic character of this downpour and its consequent flood were numerous. From one three-acre watershed of summer fallow¹ a stream of mud about 40 feet wide laid flat, along a small stream-way draining the area, a strip of wheat that would have cut 50 bushels per acre. Numerous soil "boulders" were scattered over the alluvial plain of this streamlet to a distance of 1,500 feet below the area of fallow ground. These "boulders" consisted of water-rounded (by rolling) soil, formed of large plow-developed clods of dry black surface soil (a very silty type), which were picked up from the summer fallow area. All of this work was accomplished before the "boulders" had time to soak up much moisture; otherwise they would have disintegrated and become a part of the muddy stream. Had they consisted of the less permeable clay subsoil material, this would not necessarily have been true; but with the black silty Palouse soil, such earthen "boulders" could have been formed only while the soil was still dry and hard.

Relation of Land Utilization to Erosion

Topographically, the farm land within the area¹ affected is typical of the Palouse country; the soil is largely of a type that has been classed as Palouse silt loam.² Its topography is fully as rough as that of the average land within the Palouse region, having many cultivated

¹In the Palouse belt the wheat growers practice fallow, that is, one-half of the land is devoted to wheat while the other half is summer fallowed; plowed and kept free of weeds throughout summer as a means of accumulating nitrogen and moisture.

²Bryan, Kirk—The "Palouse Soil" Problem, Bulletin 790-B, U. S. Geological Survey, 1927.

²For description of the Palouse silt loam, see J. H. Agee, George W. Graves and C. B. Mickelwsite: Soil survey of Latah County, Idaho, U. S. Dept. of Agriculture, Field Operations of the Bureau of Soils, 1915.

slopes in excess of 50 per cent gradient. The general lay of the land in this region is illustrated by Plate I. The dominant farm crop rotation, if it can be called a rotation, is winter wheat followed by summer fallow. Other areas studied following the flood were devoted to spring wheat, alfalfa bunch grass pasture, and winter wheat sown in June for summer pasture.

The summer fallow land was eroded over countless broad and narrow streaks to the average depth of plowing, or about 7 inches (down to the plow-sole), but the washing did not extend much below this level of relatively compact soil. Individual fields containing several hundred acres were estimated to have lost more than 2 inches of soil from their entire extent. One field showed, according to estimates, a loss of 6 inches or more over 25 per cent of its area, and from 1 to 6 inches over the remainder of the field. On the basis of measurements made and numerous observations, the writer is convinced that no summer fallow upland within the entire area lost less than one inch of soil during the storm. Individual tracts of one acre were found to have lost 6 inches or more of soil over 90 per cent of their total area. Some tracts of about one-tenth acre in size, lying near the base of slopes, were found to have lost from 8 to 10 inches of soil from 100 per cent of their extent. Countless rills (miniature gullies) dug down as far as the soil had been loosened by plowing. On those farms where deeper plowing had been practiced the soil losses were proportionately greater.

The washing off of the soil in summer fallowed areas was found to have started, for the most part, within 15 feet or less from the ridge crest. Thus, water accumulating within a distance of 15 feet was sufficient, on many slopes, to cut the soil away to plow-sole depth. The washes generally widened down the slope.

The rills thus developed in the loose plowed soil ranged for the most part from about 3 inches to 1 foot in width. Through lateral planation several rills combined, in thousands of instances, to form washes from 3 to 10 feet in width, the plow-sole being exposed over the entire "skinned" area (Plate VI, A). The side walls of the washes were generally vertical.

A plot of ground measuring one-tenth of an acre, selected because it was typical of conditions on steeply sloping summer fallow, is shown in Map No. 3. The area was mapped in three divisions: (a) that which lost more than six inches of soil; (b) that which lost from three to six inches; and (c) that which lost from one to three inches. The losses were determined by field measurements supplemented by detailed examination of photographs of the area. The legend on Map No. 3 shows the areal proportions of each of the classes. Assuming a weight of 75 pounds of dry soil per cubic foot,

the measurements show that this tenth-acre area lost about 73 tons of soil during this single rain. Many such areas unquestionably lost soil during this one rain at the rate of 700 tons or more per acre.

The writers are convinced that summer fallow land within this storm area lost an average of two inches of soil during this rain, the equivalent of about 275 tons per acre. Since the area comprised about 20,000 acres of summer fallow at the time of the heavy rain, it appears that about 5,500,000 tons of dry surface soil were removed from these few square miles of Palouse hills in this small area during one rain storm.

The marks of plows were plainly visible in the plow-sole of all these flat-bottomed washes (Plate III, B, and Plate VI, A). Since most of the plowing in the region is done along the contour, the plow marks were fixed, for the most part, more or less at right angles to the direction of the washes.

Some of the wheat fields had just been harvested with combines; in others the ripe winter wheat or nearly ripe spring wheat was still standing. The same heavy rain falling on grain stubble or fields of standing wheat caused little or no damage to the land. Surface water collected locally in wheat fields in sufficient quantity to form temporary streams which threw down the grain but caused no appreciable erosion. Evidence of such streams was exceptional; apparently the rain-water went largely into the ground, showing the importance of vegetation in its relation to erosion control.

Alfalfa Checks Erosion

Several alfalfa fields were carefully examined and on none of them could any marked evidence of soil washing be found. These fields had new upright shoots of alfalfa that were rather scattered and usually less than 12 inches in height since from July 1 up to the date of the rain the weather had been very dry. One field seeded to alfalfa in the spring of 1931 had a rather sparse growth, but even this showed no soil losses from the steepest slopes.

Similarly, part of a sloping field seeded in early summer to a winter wheat and pastured continuously during the early summer and showing very few spears more than an inch high, was not eroded. Summer fallow, on the slope above, however, was completely riddled by thousands of shallow erosional gashes. These gashes stopped exactly at the upper edge of the wheat pasture, without one exception. (Plate IV, A).

Numerous small areas of virgin bunch grass land where the stand was generally thin showed no rill cutting, while summer fallow fields separated from the grass land only by fence lines were completely riddled.

Certain summer fallow areas, varying in size from a very few acres to several hundred acres, occupied the heads of watersheds; other summer fallow areas covered the ridges, with ripe wheat or some other crop on the lower slopes, while in other instances these conditions were reversed. These vegetative contrasts gave incontrovertible proof of the important part that vegetation played in controlling the runoff of this great amount of water. In contrast to this evidence of control, no matter what topographic position the summer fallow occupied, erosion began within a few feet of the upper level of the fallow-ground and increased in proportion to the steepness of the slope.

It mattered not what that vegetative cover was, how steep the slope might be, or how much momentum the flood had been given by a long slope of summer fallow above, the erosion stopped in almost all instances at the point where vegetation occurred. Furthermore, all vegetation that had any appreciable height from the ground acted as a strainer or filter causing deposition of the soil, which was being carried in suspension by these runoff waters. The result was that wherever a flood of water from summer fallow went through any vegetative area there remained afterward a freshly deposited soil layer on top of the old soil surface. The depth of this layer naturally decreased as the distance from the summer fallow increased.

The striking differences between erosivity of the summer fallow and of vegetated slopes results from two major factors: first, the binding power of vegetation, and second, the less compact condition of the summer fallowed soil.

Conclusion

These observations all indicate two facts: first, that any vegetative cover offers an effective means of preventing losses resulting from soil washing and runoff in the Palouse region, and second, that the principle of summer fallowing does not make for erosion control. Results of erosion studies in all parts of the world indicate that these principles of control are equally applicable anywhere.

